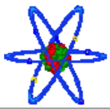
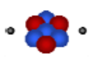


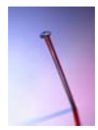
ATOMS

A Look inside at Protons, Neutrons and Electrons



How are these samples all the same? What makes them different?

IRON



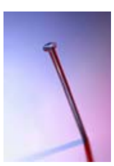
HELIUM

COPPER

Answer:

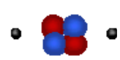
- The samples are similar in that they are all made of atoms.
- Each atom has 3 subatomic particles.
- The difference is the number of subatomic particles each sample has. This difference in the subatomic particles determines the properties of the substance.

For Example



- Iron Nail
  - Created from Iron (Fe)
  - Fe has an atomic number of 26 and a mass of 55.85

- Helium balloon
  - Created from Helium (He)
  - Helium has an atomic number of 2 and a mass of 4.003



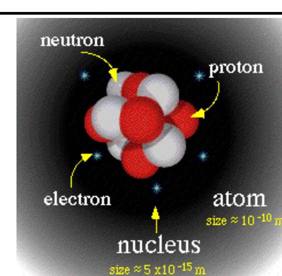
- Copper penny
  - Created from Copper (Cu)
  - Cu has an atomic number of 29 and a mass of 63.55

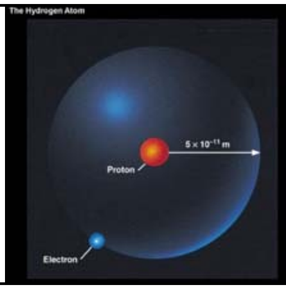
Atoms, elements and molecules

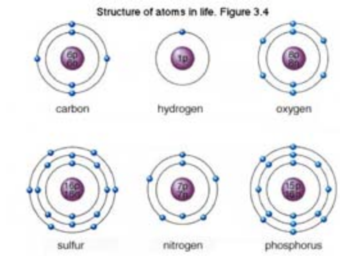
- The difference in all these objects is that they are made up of different atoms.
- Atoms are the smallest piece of a substance that still has the characteristics of that substance.
- A substance made up entirely of the same atoms is called an element.
- Different elements can bond together to form a molecule.

So, what are subatomic particles?

- The atom itself is made of protons, neutrons and electrons.
- The protons and neutrons are in the nucleus of the atom.
- The electrons orbit around the nucleus.
- There is a strong nuclear force that holds these subatomic particles together.

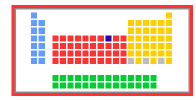




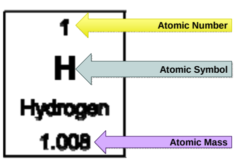


How do we determine the number of subatomic particles?

- We can determine the number of subatomic particles by looking at the periodic table.
- Each element on the table has an atomic number, name, symbol and atomic mass.



How to read the information in the periodic table



Atomic Mass

- The approximate total mass of an atom; also called atomic weight
- Given as a whole number, the atomic mass approximately equals the number of proton and neutrons
- The mass of the subatomic particles:
  - Proton = 1.6726×10^{-27} kg
  - Neutron = 1.6749×10^{-27} kg
  - Electron = 9.109×10^{-31} kg (1/1836 of a proton)

Protons

1
H
Hydrogen
1.008

Atomic number = 1

Number of Protons =?

- The number of protons is equal to the atomic number
- The proton has a positive charge: p^+
- Is located in the nucleus of the atom

38
Ni
Nickel
58.69

Atomic number = 38

Number of Protons = ?

47
Ag
Silver
107.9

Atomic number = 47

Number of Protons = ?

Electrons

1
H
Hydrogen
1.008

Atomic number = 1

Number of Protons = 1

Number of Electrons = ?

- The electron has a negative charge: e^-
- Found in energy levels (shells) around the nucleus
- The number of electrons equals the number of protons
- What would happen if the number of electrons and protons were not equal?

38
Ni
Nickel
58.69

Atomic number = 38
Number of Protons = 38
Number of Electrons = ?

47
Ag
Silver
107.9

Atomic number = 47
Number of Protons = 47
Number of Electrons = ?

Neutrons

- A neutron has a neutral charge: n^0
- Is found in the nucleus of the atom
- To determine the number of neutrons an atom has, you have to subtract the atomic mass from the atomic number
- Atomic mass – Atomic Number = Neutrons

A neutron walked into a bar and asked how much for a drink.
The bartender replied,
"for you, no charge."
-Jaime - Internet Chemistry Jokes

1
H
Hydrogen
1.008

Atomic number = **1**
Number of Protons = **1**
Number of Electrons = **1**
Number of Neutrons =
1.008 – 1 = **0.008**

How can you have 0.008 of a Neutron?
How many neutrons are really in this atom?

38
Ni
Nickel
58.69

Atomic number = **38**
Number of Protons = **38**
Number of Electrons = **38**
Number of Neutrons =?

47
Ag
Silver
107.9

Atomic number = **47**
Number of Protons = **47**
Number of Electrons = **47**
Number of Neutrons = ?

Isotopes

- Atoms of the same element with different numbers of neutrons
- Since the number of neutrons helps to determine the mass of an atom, the mass number (the number of neutrons and protons in an atom) is also different
- Because the number of protons does not change, the atomic number is the same for all isotopes of an element

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- Isotopic notation
  C-14: Number after the symbol indicates the mass number

  $^{14}_{6}C$ Top number indicates the mass #;
  Bottom number indicates atomic #.
- Brain Pop Isotopes

Electron Shells

- Electrons orbit the nucleus in electron shells
  - The maximum number of shells is 7
  - The levels are filled in order from the one nearest the nucleus
- The row number identifies the number of energy levels for the elements in that row
- Mark your periodic table with energy levels 1-7

- There is a maximum number of electrons that can fill each level
  - Shell 1 – 2 electrons
  - Shell 2 – 8 electrons
  - Shell 3 – 8 electrons

- The last shell is called the valence shell
  - It is farthest from the nucleus and has the greatest potential for chemical bonding
- Atoms will form chemical bonds to complete the valence shell
- The column number identifies the number of electrons in the valence shell
- Mark your periodic table with the 8 columns for the representative elements

Lewis Dot Structures

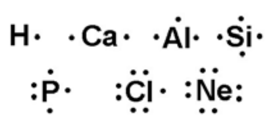
- When drawing the Lewis dot structures for atoms

  - Write the symbol of the atom to represent the nucleus and the electrons in the inner shells

  - Draw dots to represent valence electrons on the four sides of the symbol

  - Start on one side and draw up to 2 dots first, then place one dot each on the remaining three sides before placing the second dot on any of these sides (like dealing cards to three players)

Examples of Lewis Dot Diagrams



Electron Shells

- For each element listed identify
  - Atomic Mass
  - Number of protons, neutrons, and electrons
  - Number of electrons in each shell
  - The Lewis Dot Diagram
- Elements
  - C
  - H
  - N
  - O
  - P
  - S

Chemical Bonds

- Determined by the electrons in the shells
- Any shells that are filled to capacity are stable
  - Chemically inert: do not react; do not chemically bond
- Those shells not containing 8 electrons tend to gain, lose or share electrons with other atoms to achieve stability
- Octet Rule – Rule of Eights
  - Atoms tend to chemically interact in such a way as to have 8 electrons in the valence shell

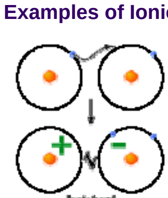
Chemical Bond Types

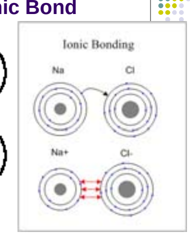
- Ionic Bonds
  - Electrons are lost or gained.
  - Atoms with 6 or 7 electrons in valence shell will gain electrons (Column 6 and column 7).
  - Atoms with 1 or 2 electrons in valence shell lose electrons (Column 1 and column 2).
- Covalent Bonds
  - Electrons are shared.
  - Atoms in Column 3,4,5 tend to share electrons.
- Hydrogen Bonds
  - Do not create molecules but alter their shape
  - Connect two molecules together

Ionic Bonds

- Cation – A positive ion formed by the loss of electrons; Groups 1 and 2
- Anion- A negative ion formed by the gain of electrons; Groups 6 and 7
- These atoms will remain close together due to the attraction of opposite charges (+ attracts -)
- Ionic bonds are formed from a metal and a nonmetal
- Brain Pop Ions

Examples of Ionic Bond

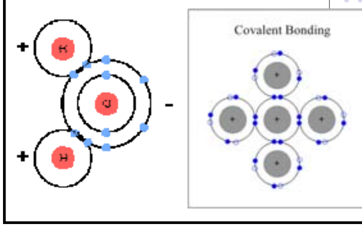




Covalent Bonds

- Occurs when atoms share electrons so that each atom can fill its valence shell some of the time
- Neither atom is strong enough to gain total control of any unpaired electrons
- There is an ongoing tug of war and these electrons remain attracted to both nuclei
- Occurs with atoms of 3, 4, 5, electrons in the valence shell
- These atoms are not charged (No ions!)
- Covalent bonds are formed by two nonmetals

Examples of Covalent Bonds



Diatomic Molecules

- Seven elements that do not occur as atoms, but bond with another atom of the same element
- End in –gen and –ine
- -gen: hydrogen (H_2), nitrogen (N_2), and oxygen (O_2)
- -ine: fluorine (F_2), chlorine (Cl_2), bromine (Br_2), and iodine (I_2)
- **H**ave **N**o **F**ear **O**f **I**ce **C**old **B**eer (Memory trick!)

Hydrogen Bonds

- Formed when a charged part of a molecule having polar covalent bonds forms an electrostatic (charge, as in positive attracted to negative) interaction with a substance of opposite charge
- Classified as weak bonds because they are easily and rapidly formed and broken under normal biological conditions

Examples of Hydrogen Bonds